Science
Module 7

Earth Science: Earth Materials and Systems

Module Goal

The goal of this module is to provide information that will help educators increase their knowledge of grade-appropriate science concepts, knowledge, and skills to support effective planning or modification of their existing science instructional units for students with significant cognitive disabilities. The module includes important concepts, knowledge, and skills for the following instruction:

- The Atmosphere (elementary) – Earth is surrounded by an active atmosphere and an energy system that controls the distribution of life, local weather, climate, and continuous global change: types of clouds; effects of oceans and mountains on weather and climate.
- The Earth (elementary) – Major geologic events that occur over eons or brief moments in time continually shape and reshape the surface of Earth, resulting in continuous global change: alteration of Earth's surface due to wind and water.
- The Atmosphere (middle) – Earth is surrounded by an active atmosphere and an energy system that controls the distribution of life, local weather, climate, and continuous global change: sun energy and wind; meteorological data to predict the weather.
- The Earth (middle) – Major geologic events that occur over eons or brief moments in time continually shape and reshape the surface of Earth, resulting in continuous global change: lithospheric plate movement, mountain building, volcanoes, and sea floor spreading.

Module Objectives

The content module supports educators' planning and implementation of instructional units in science by:

- Developing an understanding of the concepts and vocabulary that interconnect with information in the module units.
- Learning instructional strategies that support teaching students the concepts, knowledge, and skills related to the module units.
- Discovering ways to transfer and generalize the content, knowledge, and skills to future school, community, and work environments.

The module provides an overview of the science concepts, content, and vocabulary related to Earth Science: Earth Materials and Systems and provides suggested teaching strategies and ways to support transference and generalization of the concepts, knowledge, and skills. The module does not include lesson plans and is not a comprehensive instructional unit. Rather, the module provides information for educators to use when developing instructional units and lesson plans.

The module organizes the information using the following sections:

I. Science Academic Standards and Related Alternate Assessment Targets and Underlying Concepts;
II. Scientific Inquiry and Engineering Design;
III. Connecting Concepts;
IV. Vocabulary and Background Knowledge information, including ideas to teach vocabulary;
V. Overview of Units' Content;
VI. Universal Design for Learning (UDL) Suggestions;
VII. Transference and Generalization of Concepts, Knowledge, and Skills; and
VIII. Tactile Maps and Graphics.

Section I

Science Academic Standards and Related Alternate Assessment Targets and Underlying Concepts

It is important to know the expectations for each unit when planning for instruction. The first step in the planning process is to become familiar with the identified academic standards and related Alternate Assessment Targets (AATs) and Underlying Concepts (UCs) covered in the module. The AATs are specific statements of knowledge and skills linked to the grade-specific science academic standards. The UCs are basic key ideas or concepts linked to specific AATs. UCs are a basis for developing a more complex understanding of the knowledge and skills represented in the AAT and should not be taught in isolation. It is important to provide instruction on the AAT along with the UC in order to move toward acquisition of the same concepts, knowledge, and skills.

Table 1 includes the academic standards and related AATs and UCs for Earth Science: Earth Materials and Systems. While only the academic standards targeted for the Tennessee Comprehensive Assessment Program/Alternate (TCAP/Alt) are included, instruction on additional standards will aid in student understanding. Standards that are not included still represent important content for students to master. Therefore, the AATs and UCs included in the table do not cover all of the concepts that can be taught to support progress and understanding aligned to the standards.

Table 1. Science Academic Standards and Related AATs and UCs [1]

Academic Standards	Alternate Assessment Targets (AAT)	Underlying Concepts (UC)
The Earth – Major geologic events that occur over eons or brief moments in time continually shape and reshape the surface of Earth, resulting in continuous global change.		
0407.7.1 Design a simple model to illustrate how the wind and movement of water alter the earth's surface.	Recognize that wind and movement of water can alter the earth's surface.	Identify features of the earth's surface (e.g., mountain, valley, or hill).
0707.7.5 Recognize that lithospheric plates on the scale of continents and oceans continually move at rates of centimeters per year.	Identify how the shapes of the continents (fit like a jigsaw puzzle) and fossil comparisons (fit together) along the edges of continents demonstrate lithospheric plate movement.	Identify the crust or core in a model of Earth's layers.
0707.7.6 Describe the relationship between plate movements and earthquakes, mountain building, volcanoes, and sea floor spreading.	Identify the result of movements of sections of Earth's crust (e.g., earthquakes, mountain building, volcanoes, and sea floor spreading).	Recognize a description of a process such as an earthquake, flood, or volcanic eruption that can change the surface of the Earth.

Academic Standards	Alternate Assessment Targets (AAT)	Underlying Concepts (UC)
The Atmosphere – Earth is surrounded by an active atmosphere and an energy system that controls the distribution of life, local weather, climate, and continuous global change.		
0307.8.2 Match major cloud types with specific atmospheric conditions.	Recognize that there are a variety of clouds (shapes/sizes).	Identify various weather conditions (e.g. sunny or cloudy, hot or cold, windy or calm, rainy or dry).
0507.8.1 Describe the effects of the oceans on weather and climate.	Recognize that it takes more energy to change the temperature of the ocean than of the land.	Identify that it will take longer to heat a large volume of water than a small volume, when applying the same amount of heat.
0507.8.2 Explain how mountains affect weather and climate.	Recognize that when warm air rises, the water vapor in the air will cool and form rain, or snow in the winter.	Identify that mountain regions have cold temperatures.
0607.8.2 Recognize the connection between the sun's energy and the wind.	Recognize that as the sun's energy warms the air over the land (expands and rises) and the air over the ocean (cooler air) rushes in to take its place and is called wind (sea breeze).	Recognize that warm air rises and cool air sinks.
0607.8.4 Interpret meteorological data to make predictions about the weather.	Interpret weather information (e.g., map) to make predictions about future conditions (e.g., precipitation, temperature).	Interpret basic weather information (e.g., map) to identify current weather conditions.

[1] Instruction is not intended to be limited to the concepts, knowledge, and skills represented by the AATs and UCs listed in Table 1.

Section II

Scientific Inquiry and Engineering Design

It is important for students with significant cognitive disabilities to have the opportunity to explore the world around them and learn to problem solve during science instruction. This approach to science instruction does not involve rote memorization of facts, but rather it involves scientific inquiry. A Framework for K-12 Science Education (2012) unpacks scientific inquiry, providing eight practices for learning science and engineering in grades K – 12. These practices provide students an opportunity to learn science in a meaningful manner. Students should combine the science and engineering practices, as appropriate, to conduct scientific investigations instead of using a practice in isolation or sequentially moving through each practice. Support should be provided as necessary for students with significant cognitive disabilities to actively use the practices. See Section VI. Universal Design for Learning

Suggestions for support ideas. Following are the eight science and engineering practices (National Research Council, 2012) with added examples.

- Asking questions (for science) and defining problems (for engineering).

  Examples: How can a river change Earth's surface? What causes the climate to be different at the top of a mountain than at the bottom? What causes earthquakes?

- Developing and using models.

  Examples: Create a model of cloud types and locations in the sky. Use a model to understand how mountains affect the climate. Use a model of lithospheric plates (Earth's solid outer layer, i.e., the crust and upper mantle) to view how Earth's physical features are formed. Use a model to compare the position of the continents today with Pangea.

- Planning and carrying out investigations.

  Examples: Observe, track, and compare clouds and the weather over a period of days. Investigate the effects wind and water have on erosion of soil with and without plants. Track temperature changes at two specific locations (one inland and one on a shoreline) for a period of 24 or 48 hours.

- Analyzing and interpreting data.

  Examples: Analyze data showing water temperature of different size containers at time intervals to determine which heats more quickly. Analyze weather data from diverse locations and identify factors (e.g., physical features) that contribute to diverse conditions (e.g., more precipitation in one area than another). Analyze data on volcanic activity in the area known as the "Ring of Fire" and identify factors that contribute to the volcanic activity.

- Using mathematics and computational thinking.

  Examples: Record daily temperature over a period of time in a low lying area and in a mountainous area. Measure wind speed or precipitation and compare to the weather report.

- Constructing explanations (for science) and designing solutions (for engineering).

  Examples: Explain why rain is washing soil out of a garden and plan ways to slow erosion. Explain how mountains are formed. Explain how the sea floor spreads.

- Engaging in argument from evidence.

  Examples: Use reasoning to connect the relevant and appropriate evidence and construct an argument that includes the idea that air over the ocean changes temperature more slowly than air over land. Present evidence showing why weather is typically milder next to the ocean than somewhere else on the same latitude.

- Obtaining, evaluating, and communicating information.

  Examples: Communicate the idea that different types of clouds typically result in different levels of precipitation. Express the understanding that warm air rises and cool air sinks.

Science Practices Resources

This site categorizes inquiry into three types: structured inquiry, guided inquiry, and open inquiry. Each type provides a wide range of example lessons grouped by elementary and middle school.
http://www.justsciencenow.com/inquiry/

A variety of sites that provide models or directions to build models or simulations:

- Cloud type model. http://www.harcourtschool.com/activity/science_up_close/610/deploy/interface.swf
- Simulation of plate tectonics (Windows only). https://phet.colorado.edu/en/simulation/plate-tectonics
- Simulation of volcano and its formation. https://www.eduplace.com/kids/hmsc/activities/simulations/gr6/unitc.html
- Education.com provides a variety of Earth Science activities and experiments. http://www.education.com/results/earth+science/
- Creating a cloud. http://stem-works.com/external/activity/571
- Investigating what the wind carries. http://stem-works.com/external/activity/435
- Creating a model to illustrate sea floor spreading and subduction. http://stem-works.com/subjects/8-earthquakes/activities/234
- Creating a model to show Earth's layers. https://www.teachengineering.org/activities/view/cub_natdis_lesson02_activity1

Section III

Connecting Concepts

Grade-level science content includes Connecting Concepts, which are concepts that connect information between different science strands and grade levels. The Connecting Concepts are intended to work together with the science inquiry and engineering practices, in addition to core content, to enable students to reason with evidence, make sense of phenomena, and design solutions to problems. Helping students make connections between these types of concepts and new content information supports comprehension of the concepts, knowledge, and skills as well as transference and generalization (see Section VII for more information). Connecting Concepts that are specific to this module connect to content across the units within the module as well as across modules.

Connecting Concepts are a common link between multiple standards and units of study. The Connecting Concepts, by being revisited and linked to multiple units of study, become a strong foundation of understanding and support the students in learning new concepts. For example, understanding that cause-and-effect can explain and predict change is a Connecting Concept that applies to mountains' and oceans' effect on climate; effects of wind and water on Earth's surface features; high/low pressure area's effects on weather, etc. Some Connecting Concepts may apply across multiple content areas and instructional emphases (e.g., cause-and-effect related to historical events).

This science content module addresses how water, ice, wind, and gravity break rocks, soils, and sediments into smaller pieces and move them around. Energy flows and matter cycles within and among Earth's systems, including the sun and Earth's interior as primary energy sources.

Teaching Connecting Concepts

The following strategies pulled from the principles of UDL (CAST, 2011) are ways in which to teach Connecting Concepts to help students understand the concepts and make connections between different curricular content. During instruction, highlight:

- patterns (e.g., Point out the pattern of cooler temperatures in mountains compared to warmer temperatures in the area at the base of mountains.),

- critical features (e.g., Emphasize the shapes and colors of cloud types.),
- big ideas (e.g., All Earth processes are the result of energy flowing and matter cycling within and among Earth's systems. Explain that warm air rises and cool air sinks.), and
- relationships (e.g., Make the connection between movement of water in rivers and how it can change Earth's surface. Earth's atmosphere is made up of many layers, and without it, life could not exist. Each layer has specific characteristics that include composition and temperature. All of Earth's processes are the result of energy flowing and matter cycling within and among these systems.

For example, the motion of tectonic plates is part of the cycles of convection in Earth's mantle, driven by outflowing heat and the downward pull of gravity, which result in the formation and changes of many features of Earth's land and undersea surface.

Following are **Connecting Concepts** for this Content Module – Earth Science: Earth Materials and Systems.

Understand

Patterns

- Patterns can be used to determine similarities and differences.
- Patterns can be observed and used as evidence (e.g., locations of mountain ranges, deep ocean trenches, etc.).
- Patterns can be used to identify cause-and-effect relationships.
- Patterns related to time, including simple rates of change and cycles, can be used to make predictions.

Cause and Effect

- Events that occur together with regularity might or might not have a cause-and-effect relationship.
- Some phenomena may have more than one cause.
- Cause-and-effect relationships may explain change.

Scale, Proportion, and Quantity

- Natural objects and observable phenomena exist from the very small to the immensely large.
- Models using scale can be used to study systems that are too large or too small.

Systems and System Models

- A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.
- System parts work together (e.g., In many systems there also are cycles of various types. For example, water going back and forth between Earth's atmosphere and its surface and subsurface reservoirs).
- Models are used to represent systems and their interactions.

Energy and Matter

- Objects may break into smaller pieces, can be put back together, and may change shape.
- Matter is made of particles and energy that can be transferred in various ways and between objects.
- Energy drives the motion and/or cycling of matter.

Stability and Change

- Some things stay the same while some things change.
- Things may change slowly or rapidly.
- Some systems appear stable, but change over time.
- Small changes in one part of a system might cause large changes in another part.
- Stability might be disturbed by either sudden events or gradual changes that accumulate over time.

Connecting Concept Resources:

Grant Wiggins talks about "big ideas" in this article.
http://www.authenticeducation.org/ae_bigideas/article.lasso?artid=99

A Framework for K-12 Science Education, Appendix G explains the crosscutting concepts and how the concepts help students deepen their understanding of the information.
http://www.nextgenscience.org/sites/default/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf

TeacherVision provides ten science graphic organizers that are free and printable.
https://www.teachervision.com/graphic-organizers/science/52539.html

Utah Education Network provides a variety of student interactives for:

- grades three through six. http://www.uen.org/3-6interactives/science.shtml
- grades seven through twelve. http://www.uen.org/7-12interactives/science.shtml

Section IV

Vocabulary and Background Knowledge

Vocabulary is critical to building an understanding of science concepts, knowledge, and skills. The vocabulary words that students gain through experiences provide ways for students to comprehend new information (Sprenger, 2013). Students can better understand new vocabulary when they have some background knowledge to which they can make connections. In addition, learning new vocabulary increases students' background knowledge. Therefore, it is important to teach vocabulary purposely when introducing new concepts, knowledge, or skills (e.g., weather and climate) and in the context of the specific content (e.g., Teach the terms "temperature," "precipitation," "cold front" and, "warm front" while working with a weather map and/or observing and charting the weather.).

This module includes two types of vocabulary words, both equally important to teach. The first type, **general vocabulary words,** labels groups of words that generalize to a variety of Earth's systems and phenomena. For example, understanding the meaning of the word "cloud" helps students to connect different types of clouds, how to describe each type, and predict chance of precipitation for each. The second type, **specific content words,** represents groups of words that are associated with an organism, system, process, or phenomena. Specific content words, such as "lithospheric plates," connect to general words related to results of lithospheric plate movement (e.g., earthquakes and volcanoes). Providing exposure and instruction on general words provides background knowledge when introducing corresponding or related specific words.

Key Vocabulary for Instructional Units

Table 2 and Table 3 contain lists of key general vocabulary words and specific content words that are important to the units in this module. The vocabulary words span across grades three through eight; refer to the TN science standards to identify grade-specific words. Teach general vocabulary words to the student using a student-friendly description of the word meaning (e.g., A mountain is land that is higher and steeper than the land around it.) and an example of the word (e.g., Great Smoky Mountains). Teach the specific content vocabulary using a student-friendly description of the word meaning (e.g., A weather map is a map that shows cold and warm fronts, high and low air pressure, and wind direction.) and a possible connection to a general vocabulary word (e.g., A weather map helps predict the temperature and if it will be cloudy or sunny.).

Do not teach memorization of vocabulary words; instead, place emphasis on understanding the word as a result of observation, investigation, viewing a model, etc. For example, a student should learn to identify or describe an ocean and not be required to define the term "ocean."

Table 2. General Vocabulary Words

General Vocabulary – words that generalize to different animals, plants, organisms, and activities. Describe the word and provide examples (e.g., climate – describe what the weather is like in a place over a year or more. *Example: Tennessee's climate is warm summers and mild winters.).*

• atmosphere	• eruption	• physical feature	• sun/sunny
• average	• evaporation	• precipitation	• temperature
• circulation	• flood	• predict/prediction	• valley
• climate	• heat energy	• rainfall	• volcano
• cloud/cloudy	• hill	• rain/rainy	• volume
• coastal	• magma	• river	• water vapor
• degrees	• mountain/mountain range	• snow/snowy	• wave
• earthquake	• ocean	• soil	• weather
• erosion	• particles	• storm/stormy	• wind

Table 3. Specific Content Words

Specific Content Words – words that specify a particular thing (e.g., cirrus cloud) or phenomena (e.g., cold front). Describe the word and when possible make the connection to a Connecting Concept (e.g., A cirrus cloud is a thin and feathery cloud that is very high in the sky. Cirrus clouds usually mean it will be nice weather with blue skies.).

• altitude	• cumulus cloud	• mantle
• atmosphere	• Earth	• oceanic crust
• Celsius	• Earth's surface	• sea floor spreading
• cirrus cloud	• high pressure area	• solar energy
• cold front	• hydrosphere	• stratus cloud
• core	• lithospheric plates	• warm front
• crust	• low pressure area	• weather map

Ideas to Support Vocabulary Learning

Table 4 includes ideas and examples for teaching vocabulary in ways to build conceptual understanding of the words.

Table 4. Ideas to Teach Vocabulary Effectively (Marzano, 2004)[2]

Ideas	Examples
Explain, describe, and/or give examples of the vocabulary word rather than formal definitions.	Provide a description/example of a physical feature, "Mountains, hills, valleys, and rivers are physical features on Earth's surface."
Have students restate the vocabulary word in their own words. Take this opportunity to help students connect new vocabulary, especially general vocabulary, to prior knowledge.	• Have students state in their own words (verbally or using alternative and augmentative communication [AAC] system) that an earthquake is when the ground shakes because of lithospheric plate movement. Help students make the connection to prior knowledge by showing an earthquake clip from recent news or a familiar movie.
Have students represent vocabulary words in a variety of ways (e.g., pictures, symbols, graphic organizers, or models).	• Ask students to complete a weather vocabulary graphic organizer (see Figure 1), providing support as needed (e.g., help from peer or adult, viewing model, using AAC, etc.). Adapt the task as needed to include more pictures, objects, and/or textures. • Create an Earth Science word wall using color photographs as visual support, arrange words to illustrate relationships, and include student generated material (e.g., definitions, examples, drawings).
Provide multiple exposure to vocabulary words in a variety of ways. This does not suggest mass trials, rather distributed trials in different ways or contexts. Reference http://projectlearnet.org/tutorials/learning_trials.html for information on learning trials.	• Expose students by incorporating vocabulary into daily activities when it is appropriate (e.g., discuss the cloud types, the weather for the day, etc.). • Have students complete an online interactive vocabulary activity (e.g., http://www.esolcourses.com/topics/weather-months-seasons.html). • Have students review flashcards that include images and recorded definitions (e.g., https://quizlet.com/126657585/weather-flash-cards/). • Have students sort photos of weather conditions into the associated cloud types.

Ideas	Examples
Ask students to discuss the vocabulary words with each other.	• Have students use their preferred mode of communication to share examples of words (e.g., weather, climate, erosion). Adapt by placing examples of the vocabulary words on a voice output device and have the student share with a classmate. • Have students share their representations (e.g., drawings or pictures) of a word with each other.
Play vocabulary word games with students.	• Shine a flashlight on the science area of the classroom word wall and ask a student to define/describe the word. Next, that student shines the light on a different word and asks another student to define/describe the word. • Have students match a description or representative picture to a word. • Have students play a plate tectonics jeopardy type game (e.g., https://jeopardylabs.com/play/plate-tectonics-review-game).
Have students watch a dramatization or have them act out the vocabulary term.	• Watch a video on earthquakes and volcanoes (e.g., https://www.youtube.com/watch?v=yWezU1P6dM0).

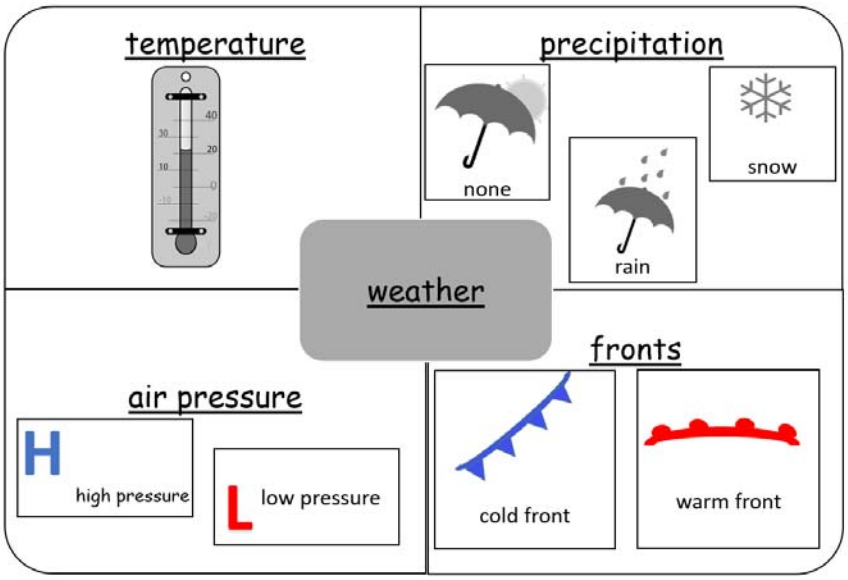
[2] Refer to Section VI, Universal Design for Learning (UDL) Suggestions for additional instructional strategies.

Vocabulary Example

Have students complete a weather vocabulary graphic organizer by writing or pasting weather related vocabulary on the graphic organizer (see Figure 1). Educators may need to support, modify, or adapt steps as needed for individual students. For example, read everything to the student, provide the descriptions on the student's AAC system, use tactile representations for vocabulary, etc. Two National Center and State Collaborative (NCSC) resources are available and may prove helpful:

- Use systematic instruction as described in the NCSC Instructional Guide. https://wiki.ncscpartners.org
- Reference ideas in the NCSC Vocabulary and Acquisition Content Module. https://wiki.ncscpartners.org

Figure 1. Example Weather Vocabulary Graphic Organizer



Vocabulary Resources:

Vocabulary.com provides explanations of words using real-world examples. Once signed in, an educator can create word lists for students. http://www.vocabulary.com/

Text Project provides Word Pictures that are free for educators to use. It includes word pictures for core vocabulary and various content areas, including science and social studies. This link will take you to the Word Pictures page where you can select the category of words you want to use. http://textproject.org/classroom-materials/textproject-word-pictures/

This site provides effective strategies for teaching science vocabulary. http://www.learnnc.org/lp/pages/7079

The Science Penguin site provides ideas to teach science vocabulary. The vocabulary demonstration activity uses real objects to teach vocabulary terms. http://thesciencepenguin.com/2013/12/science-solutions-vocabulary.html

This article explains the power of using interactive word walls and provides examples for science. http://static.nsta.org/files/ss1103_45.pdf

Section V

Overview of Units' Content

This section of the module contains additional content and references to support educators' understanding and instruction of the instructional units. The information reflects important content to address the AATs and to build students' knowledge, skills, and abilities; however, it is not exhaustive and should be expanded upon as appropriate.

The Earth (elementary) – Major geologic events that occur over eons or brief moments in time continually shape and reshape the surface of Earth, resulting in continuous global change.

Content

- Earth's surface features include mountains, valleys, hills, and rivers.
- Water exists as solid ice and in liquid form. It carries soil and rocks from one place to another.
- Wind and water can change Earth's surface over long and short periods of time.
- Wind picks up and blows loose particles and dust away.
- Rivers wash away particles along the bottom.
- Ocean waves crashing against the shore break off pieces of rock and coastline.
- Floods and heavy rainstorms cause water to run quickly and powerfully over land causing particles to be washed away.
- Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

The Atmosphere (elementary) – Earth is surrounded by an active atmosphere and an energy system that controls the distribution of life, local weather, climate, and continuous global change.

Content:

- Clouds are made of tiny water droplets or ice particles.
- The three main types of clouds are: cirrus, stratus, cumulus.
- The appearance of clouds (e.g., thin, dark, round, white, fluffy, tall, wide, etc.) and their location in sky (e.g., high or low) can be associated with certain weather conditions.
- Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.
- Large volumes of water take longer to heat than small volumes of water when the same amount of energy is applied.
- The temperature of the ocean changes more slowly than land.
- The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate.
- Coastal locations are often cooler in the summer and warmer in the winter due to the slow temperature change of the ocean and winds that blow air onto land.
- Oceans store solar energy, which is spread around the world through ocean currents and winds.
- The average temperature at the top of a mountain is lower than at the base of a mountain.
- Winds carry warm moist air over land and up a mountain; the warm air rises and travels up a mountain, the air cools, and often forms rain or snow.
- Mountains can block rain, causing one side to have rain and the other side to be dry and desert like.
- Scientists record the patterns of the weather across different times and areas so they can make predictions about what kind of weather might happen next.

The Earth (middle) – Major geologic events that occur over eons or brief moments in time continually shape and reshape the surface of Earth, resulting in continuous global change.

Content:

- Earth has three major layers: crust, mantle, and core.
- Scientist believe that at one time the continents were connected and then gradually separated by lithospheric plate movement.
- Maps depicting ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart.
- Evidence of the continents being connected include the shapes of the continents, and fossil and rock similarities from continents no longer connected.

- All subducted plates are oceanic, which keeps the ocean floor in a constant state of change; whereas, the continents change much more slowly in geologic time. Erosion plays a large role in changing continental surface features.
- Lithospheric plates move in a diverging, converging, and/or transforming directions.
- Lithospheric plate movement causes earthquakes, mountain ranges, volcanoes, volcanic eruptions, and sea floor spreading.
- Earthquakes, floods, and volcanic eruption cause changes to the surface of Earth.
- Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans.

The Atmosphere (middle) – Earth is surrounded by an active atmosphere and an energy system that controls the distribution of life, local weather, climate, and continuous global change.

Content:

- The sun's energy heats Earth's surface, and the surface heats the air above it.
- The sun's energy heats Earth's surface unevenly.
- Warm air rises and cool air sinks.
- As the sun warms the air, the warm air rises and cool air moves in to replace the warm air resulting in wind.
- On a hot summer day, air over land is warmer and rises and the cooler air over the ocean moves in resulting in a sea breeze.
- A weather map displaying cold fronts, warm fronts, high pressure areas, and low pressure areas is used to predict the weather.
- The patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things.

Unit Content Resources:

Perkins School for the Blind has short videos that explain the importance of tactile graphics and information on spatial relationships and graphic literacy, moving from models to graphics, and strategies for reading tactile graphics. http://www.perkinselearning.org/videos/webcast/teaching-tactile-graphics

Earth's Surface

- Ducksters has information on erosion. http://www.ducksters.com/science/earth_science/erosion.php
- One Geology Kids has information on ways that Earth is changing. http://www.onegeology.org/extra/kids/earthprocesses/home.html
- Science for Kids provides basic information on erosion. http://www.scienceforkidsclub.com/erosion.html
- This site provides a lesson plan on the reasons Earth's surface changes. http://clearintotheclassroom.com/teachers/stem-lesson-plans/why-does-the-earths-surface-change/
- DLESE provides a wide variety of lesson plans and resources. http://www.dlese.org/library/index.jsp

Clouds

- UCAR Center for Science Education provides information on clouds and learning activities. http://scied.ucar.edu/teaching-box/clouds
- Scholastic has directions for observing and tracking clouds. http://teacher.scholastic.com/activities/wwatch/index.htm
- This site provides basic information on clouds for students. http://www.metoffice.gov.uk/learning/weather-for-kids/clouds
- Kidspot has directions for making a cloud in a jar. http://www.kidspot.com.au/things-to-do/activities/how-to-make-a-cloud-in-a-jar
- My NASA Data provides a variety of lesson plans and activities about clouds, weather, and temperature. https://mynasadata.larc.nasa.gov/lesson-plans/lesson-plans-middle-school-educators/

Ocean and Mountain Effect on Weather and Climate

- Teach Ocean Science provides an activity-based lesson plan on local weather and the ocean. http://teachoceanscience.net/teaching_resources/education_modules/observing_the_ocean/access_classroom_resources/local_weather_and_the_ocean
- These sites provide lesson plans on oceans' and mountains' effects on the weather and climate. http://stemteachersnowpdproject.wikispaces.com/file/view/OceansClimateMountains.pdf and https://stemteachersnowpdproject.wikispaces.com/file/view/Revised+Lesson+on+How+Mts.+Affect+Weather+and+Climate.doc
- This site has information and a diagram on mountain ranges near oceans and the effect they have on climate. https://www.arm.gov/education/outreach/publications/11JanNewsletter.pdf

Lithospheric Plate Movement

- This site provides unit plans on lithospheric plates and building mountains. http://geologyunitplan.weebly.com/mountain-building-lesson.html
- This provides a video of plate tectonics. http://www.pbslearningmedia.org/resource/ess05.sci.ess.earthsys.plateintro/plate-tectonics-an-introduction/
- Teaching Engineering has a lesson plan on how mountains are formed. https://www.teachengineering.org/lessons/view/cub_rock_lesson04
- This US Geological Survey site provides information on how the Southern Appalachian Mountains were formed. http://pubs.usgs.gov/gip/birth/birth.pdf
- National Geographic has information on sea floor spreading. http://nationalgeographic.org/encyclopedia/seafloor-spreading/
- Science-Class provides a variety of lesson and activities related to plate tectonics. http://science-class.net/archive/science-class/Geology/plate_tectonics.htm

Wind and Weather Data

- This site explains air movement and wind. http://midwaymsscience.weebly.com/uploads/8/2/9/8/8298729/section_3_-_air_movement_and_wind.pdf

- Education.com has an activity that demonstrates where wind comes from. http://www.education.com/activity/article/where_wind_comes_from_fourth/
- UCAR provides overview of weather symbols used on weather maps. https://scied.ucar.edu/webweather/thunderstorms/make-weather-forecast
- Better Lesson provides a lesson plan and materials for using weather maps to predict the weather. http://betterlesson.com/community/lesson/36790/weather-maps-day-11
- Georgia Weather School has lesson lessons and labs focused on weather and wind data. http://georgiaweatherschool.com/middle-school-activities/

Section VI

Universal Design for Learning (UDL) Suggestions

Three principles of UDL guide development of instruction, instructional materials, and assessments to provide access to learning to the widest range of students. Students with significant cognitive disabilities, especially students with visual and/or hearing impairments and students with complex communication needs, require additional scaffolds, adaptations, and modifications to access content and support learning. The three principles of UDL establish a framework for providing these. UDL provides guiding principles to create instructional materials and activities in a flexible manner to address the needs of different types of learners. Additionally, the flexibility allows for further individualization.

Table 5 provides strategies and examples for the UDL Principle I, **Multiple Means of Representation**: presenting information in a variety of ways to address the needs of different types of learners. Table 6 provides strategies and examples for the UDL Principle II, **Multiple Means of Action and Expression**: providing a variety of ways for students to interact with the instructional materials and to demonstrate understanding.

Table 7 provides strategies and examples for the UDL Principle III, **Multiple Means of Engagement**: providing a variety of ways to engage and motivate students to learn.

These strategies can assist all students in understanding the basic concepts. Some of the examples include adaptation ideas for students with vision, hearing, and/or physical limitations. Each example has a code to indicate when it includes specific adaptation ideas for these needs:

V = visually impaired (low vision, blind, or deaf-blind)
H = hearing impaired (deaf, hard of hearing, or deaf-blind)
P = physical disability (limited use of hands)

Table 5. Instructional strategy ideas using the UDL Principle: Multiple Means of Representation

Multiple Means of Representation	
Strategies	**Examples**
Introduce information through a multi-sensory approach (e.g., auditory, visual, tactile).	Make a cloud model using a solar bag made from trash bags (e.g., http://www.wikihow.com/Make-a-Solar-Hot-Air-Balloon) or purchased commercially (e.g., http://www.perkinselearning.org/accessible-science/cloud-models-solar-bag). **V** Demonstrate how air rises when it hits a mountain by having a small fan blow against a slanted board. **V** Demonstrate erosion caused by water (e.g., https://www.youtube.com/watch?v=im4HVXMGI68).
Model content through pictures, dramatization, videos, etc.	Build a three-dimensional model of Earth's surface features using (e.g., http://www.cooks.com/rec/search/0,1-0,salt_dough_maps,FF.html). **V** Watch a video on clouds. (e.g., http://nasaeclips.arc.nasa.gov/playlists/ourworld?v=our-world-cool-clouds or http://www.pbslearningmedia.org/resource/evscps.sci.life.clouds/clouds-and-weather/). Watch a video clip with information about air pressure and wind (e.g., http://studyjams.scholastic.com/studyjams/jams/science/weather-and-climate/air-pressure-and-wind.htm).
Present information using modified graphic organizers (e.g., simplified organizers with pictures) and models (e.g., tactile and pictures).	Use a KWHL to help students make connections between what they already **K**now, **W**hat they want to know, **H**ow they can find out, and finally, what they **L**earn. (Here's a slide show explaining the use of the KWHL chart and how it was made accessible for students with significant cognitive disabilities: http://www.cehd.umn.edu/nceo/teleconferences/tele14/CourtadeFlowers.pdf). **V/H/P** Demonstrate how winds form using a tactilely enhanced diagram (e.g., https://www.teachervision.com/tv/printables/concepts/es_transparencies_16.pdf). **V** Create a tactile model of lithospheric plate movement (e.g., http://www.ehow.com/video_12232651_make-model-tectonic-plates-elementary-students.html). **V**
Provide appropriate and accessible text on the content for students to listen to or read.	Have students read/listen to an online text about earthquakes (e.g., http://bookbuilder.cast.org/view.php?op=view&book=28347&page=1), lithospheric plates (e.g., http://bookbuilder.cast.org/view.php?op=view&book=41375&pa

	ge=1), and wind (e.g., http://bookbuilder.cast.org/view.php?op=view&book=41389&page=1). Read a text about clouds that includes descriptions of the clouds along with pictures (e.g., http://scool.larc.nasa.gov/pdf/ElementaryGLOBE_Clouds_en_HiRes.pdf). Provide students with text read online (e.g., http://extension.illinois.edu/treehouse/clouds.cfm?Slide=5).
Teach information using songs.	Teach sea floor spreading using a song (e.g., https://www.youtube.com/watch?v=uAa8IbXxF1c). Teach about continental drift, earthquakes, and volcanoes using songs (e.g., https://www.youtube.com/watch?v=sA6oZ4YgKCA&list=PLG3IDZYL_cHMsM36vGIVnlutdr0Ggcby4&index=2).

Table 6. Instructional strategy ideas using the UDL Principle: Multiple Means of Action and Expression

Multiple Means of Action and Expression	
Strategies	**Examples**
Use assistive technology to allow the student to interact with the instructional materials and content.	Have students use an adapted mouse to engage with an interactive site demonstrating how different forces affect Earth's surface (e.g., http://sciencenetlinks.com/interactives/shapeitup_final.swf). P Use an adapted switch attached to a personal size fan to experiment with wind erosion (e.g., http://www.spacegrant.hawaii.edu/class_acts/Wind.html).
Present instructional materials in a manner that provides access.	Place printed text and pictures on a slant board. **V/P** Have students read/listen to information on how mountains affect climate and surrounding land (e.g., http://primaryhomeworkhelp.co.uk/mountains/climate.htm) using a screen reader. **V** Have students keep a weather journal for two locations (e.g., one local and one in a coastal area of the same latitude or one in mountainous area and one in a low lying area). Provide tactile representations of temperature, precipitation, sun, cloud types, etc., for students to choose to place in the weather journal. **V/P**
Provide adapted switches, voice output devices, or tactile choices for students to select an answer.	Record correct answers and distractors on a voice output multiple message switch or multiple voice output switches and have students answer questions using the switch. **P** Have students use three switches with generic labels (e.g., a, b, c; red, blue, green; or three different textures) to which they listen, and then select the correct answer. **V/P** Ask questions that can be answered with yes/no responses or with answer choices using an adapted switch, voice output switch, or tactile representation.

Provide simulation activities.	Have students view a model simulation of lithospheric plate movement (e.g., http://www.oercommons.org/courses/plate-tectonics-animation/view). Have students create a sea breeze experiment (e.g., http://boyslife.org/hobbies-projects/funstuff/2859/weather-experiments/) to demonstrate how the ocean affects weather and climate.
Create a digital graphic organizer that allows drag-and-drop.	Have students use an adapted mouse to drag-and-drop weather symbols on a weather map based on weather data collected (e.g., http://www.glencoe.com/sec/science/activities/weather/). **P**

Table 7. Instructional strategy ideas using the UDL Principle: Multiple Means of Engagement

Multiple Means of Engagement	
Strategies	**Examples**
Provide a schedule and visual timer.	Provide personal schedules with tangible symbols. Have students select the next activity on the schedule and set the visual timer to indicate how long the student has before a break. Provide a visual and/or auditory cue (e.g., http://pricklypearcoop.schoolwires.com/cms/lib07/MT08000619/Centricity/Domain/8/B.%20Strategies%20for%20Transitions%20in%20School.pdf) to prepare students to transition from one activity to another. Use a first/then schedule (e.g., http://www.autismclassroomresources.com/visual-schedule-series-first-then/).
Vary the challenge and amount of information presented at a time.	Begin with having students identify clothing appropriate for various locations, some being in the mountains and others being in surrounding low areas to build the understanding that it is cooler in the mountains. Then provide instruction on what causes the mountains to be cooler.
Make connections to topics or activities that are motivating.	Ensure activities are age and grade appropriate. Show a popular movie clip that shows lithospheric plate movement (e.g., https://www.youtube.com/watch?v=TzzGPfVx32M) and then introduce information on lithospheric plate movement. Visit a news studio to view the way a weatherman predicts weather or invite a local meteorologist to visit the class.
Allow choices as possible.	Allow students to choose where to work on a task, the tools to use for completing a task, type of reward or recognition for completing a task, etc.
Provide opportunities to work collaboratively with peers.	Provide opportunities for students to work in a general education classroom with peers when learning about predicting weather.

	Include students in general education classroom for all instruction on a topic, not just during experiments.
Teach student self-regulation skills.	Provide communication symbols to request a break or express feelings and model how to use them appropriately. Provide students with stress balls, finger fidgets, etc. Have an adult or peer model setting of goals and self-evaluation of identified goals.

UDL Resources

The National Center on Universal Design for Learning has a plethora of information on UDL along with examples and resources. www.udlcenter.org

The UDL Curriculum Toolkit provides two applications for science.
http://udl-toolkit.cast.org/p/applications/l1

Perkins School for the Blind provides life science activities for students who are blind or have low vision.
http://www.perkinselearning.org/accessible-science/activities/life-science

This Perkins School for the Blind video, 20 minutes long, describes the techniques used to make science accessible for students who are blind and deaf-blind. https://www.youtube.com/watch?v=tpAejot1-Ec

Symbaloo is a free online tool that allows an educator to create bookmarks using icons. It is easy to create and allows an educator to provide students links to sources of information that can be used for specific instructional units. www.symbaloo.com

This site provides a brief description of Symbaloo and multiple ways to use the online tool.
https://www.theedublogger.com/2014/04/09/11-ways-to-use-symbaloo-in-the-classroom/

Perkins School for the Blind provides information on using tangible symbols to increase communication, create personal schedules, and provide choices.
http://www.perkinselearning.org/videos/webcast/tangible-symbols

Section VII

Transference and Generalization of Concepts, Knowledge, and Skills

For learning to be meaningful for all students, including students with significant cognitive disabilities, it is important to intentionally make connections to future content, real-world applications, and college and career readiness skills. For example, students can learn that the way they discover information through observation and investigation can also be used to problem solve daily living tasks. Additionally, the instruction of science concepts, knowledge, and skills may be the catalyst to developing other areas such as needed communication skills, reading/listening comprehension, mathematic skills, age-appropriate social skills, independent work behaviors, and skills in accessing support systems. Table 8 provides instructional ideas to help transfer and generalize concepts, knowledge, and skills and suggested opportunities to embed other skills into instruction.

Table 8. Transfer and Generalization Ideas

Area	Instruction	Opportunity to Embed Skills
Communication	While teaching vocabulary, make connections to real-life or future opportunities to use the words (e.g., discussing weather related events with co-workers) or understand the concepts (e.g., while watching the weather and news).	Use the context of the content area instruction to increase language skills, work on articulation, or access alternative and augmentative communication (AAC) systems.
Reading and Listening Comprehension	Provide information through reading books and articles (e.g., https://newsela.com/articles/#/category/science) on science concepts while working on reading comprehension.	Provide practice on communication skills when students are answering questions about the book or article.
Mathematics	Teach fractions when determining cloud coverage (e.g., http://scool.larc.nasa.gov/lesson_plans/SoiActivityCloudCoverage_en.pdf).	Provide practice on number identification, sequence, relative quantity or size (e.g., which is more?), etc.
Age-Appropriate Social Skills	Make connections between the Connecting Concepts and real-life experiences showing how they can help students make decisions (e.g., understanding patterns can help students determine appropriate clothing for the weather/season).	Provide opportunities to work along same-age peers to practice age-appropriate social skills and serve a vital role in the group.
Independent Work Behaviors	Encourage and reinforce independent completion of tasks to build independent work skills.	Use positive behavior supports to encourage and reinforce independent work skills.
Skills in Accessing Support Systems	Encourage students to ask appropriately for assistance from peers and adults when working on the content.	Use this time to have the student work on behavior and communication skills.

Section VIII

Tactile Maps and Graphics

The maps and graphics guidelines will help create tactile versions of instructional maps, diagrams, models, and timelines to use with students who are blind or deaf-blind. The tactile maps and graphics may be beneficial to other students as well. A tactile graphic is a representation of a graphic (e.g., picture, drawing, diagram, map, etc.) in a form that provides access through touch. It is not an exact copy of the graphic. The section provides basic guidance and links to more comprehensive resources.

Importance of Tactile Maps and Graphics

It is important to provide tactile graphics for young readers (BANA, 2010). It helps students understand and gain information when presented with science and social studies concepts, knowledge, and skills. Science instruction often presents diagrams (e.g., water cycle) and two-dimensional models of living and nonliving things (e.g., model of cell) to teach the related concepts. Social studies instruction often uses maps and timelines to illustrate where and when people existed and events occurred. The following guidance includes information to build upon when creating tactile graphics.

Tactile Graphic Guidance

1. **Determine need for graphic:** When encountering graphics in instructional materials, determine if the graphic is essential to understanding the concept. The Braille Authority of North America (2010) provides a decision tree to help in this determination. It can be accessed online at http://www.brailleauthority.org/tg/web-manual/index.html by selecting "Unit 1 Criteria for Including a Tactile Graphic."
2. **Consult with the local educator trained to work with students with visual impairments.**
3. **Determine the essential information in the graphic.** Read the surrounding information and the caption to determine which information in the graphic to exclude. For example, a map to illustrate location of key countries would not need state lines and capital cities and may not need all of the surrounding countries.
4. **Reduce unnecessary detail in the graphic.** Identify details that are not necessary for interpreting the information in the graphic. For example, a model of the water cycle may show crevices on the mountains, leaves on a tree, and waves in an ocean. Eliminate unnecessary details, as they are difficult to interpret tactilely.
5. **Remove frames or image outlines if they serve no purpose.** Ensure that all lines are necessary (e.g., line that indicates a body of water), and remove any that are not.
6. **Modify the size of the graphic.** Modify the graphic as needed to reduce clutter and allow a blank space between adjacent textures. Additionally, consider the size of the student's hand.
7. **Use solid shapes as feasible.** When solid shapes do not clearly represent the information, use clear solid lines.
8. **Systematically teach exploration and interpretation of tactile graphics.** Systematic instruction and repetition are important when teaching a student to understand a tactile graphic. Pairing the tactile graphic with a 3-dimensional object may help (e.g., pair a raised line drawing of a pencil, an example of goods, with a pencil).

Specific Graphic Type Guidance

Following is information for specific types of graphics that may support instruction in science and social studies.

Graphic Organizers/Concept Maps

- It is best to present information to compare or make connections in a tactile graphic. A tactile graphic presents the information in a spatial display and aids in comparison better than a list.

Diagrams/Models

- Limit the number of areas, lines, and labels. Having more than five makes interpretation difficult.
- Consider pairing a tactile graphic with a 3-dimensional model.

Timelines

- Present timelines in the same direction every time (i.e., horizontal or vertical).

Maps

- Distinguish water from land using a consistent background texture for the water.
- Align the direction of the compass rose arrows with the lines of longitude and latitude on the map.

Creating Tactile Graphics

Following are some ways to create tactile graphics. Additional information can be found at www.tactilegraphics.org.

Commercial products:

- Capsule paper or swell paper – print
- Thermoform

Textured shapes can be made from:

- Sticky back textured papers found at craft stores
- Corrugated cardboard
- Fabric with texture (e.g., corduroy, denim)
- Silk leaves
- Cork
- Felt
- Vinyl
- Mesh tape (used for drywall)
- Sandpaper

Raised lines can be made from:

- Glue (best not to use water-based glue)
- Wax pipe cleaners

Resources

Creating Tactile Graphics, created by the High Tech Center Training Unit, provides basic principles of tactile graphics, characteristics of good tactile graphics, the planning process, guidelines for designs, and more. http://www.htctu.net/trainings/manuals/alt/Tactile_Graphics.pdf

The Texas School for the Blind and Visually Impaired provided basic principles for Preparing Tactile Graphics, element arrangement on a tactile graphic, resources for preparing quality graphics, etc. http://www.tsbvi.edu/graphics-items/1465-basic-principles-for-preparing-tactile-graphics

Perkins School for the Blind has short videos that explain the importance of tactile graphics and information on spatial relationships and graphic literacy, moving from models to graphics, and strategies for reading tactile graphics. http://www.perkinselearning.org/videos/webcast/teaching-tactile-graphics

Perkins School for the Blind has information on how to use Play-Doh to illustrate science concepts for students who are visually impaired. http://www.perkinselearning.org/videos/teachable-moment/tactile-science-lesson-using-play-doh

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